Nature has been a source of medicinal agents for thousands of years. Folk medicines of almost all civilizations of the world abound in herbal remedies. Majority of the traditional medicines used in healthcare are obtained from plants (Kala et al., 2004). In spite of several advancements in the field of synthetic drug chemistry and antibiotics, plants continue to be one of the major raw materials for drugs treating various human ailments. Clinical and pharmaceutical investigations have in fact elevated the status of medicinal plants by identifying the role of active principles present in them and elaborating on their mode of action in human and animal systems (Dutta, 1973).

A medicinal plant is defined as any plant which has compounds that can be used for the therapeutic purpose or which contain precursors of chemo pharmaceutical synthesis (WHO, 1977). Throughout the world, plants are used traditionally to treat many ailments, particularly infectious diseases, such as diarrhea, fever, cold as well as for the purpose of birth control and dental hygiene (Mitscher et al., 1987). In addition many psychoactive substances used in traditional medicine are of plant origin (Deans and Svodoba, 1990). Traditionally used medicinal plants produce a
variety of known therapeutic properties (Chopra et al., 1992; Harborne and Baxter, 1995; Ahmed and Beg, 2001).

**Herbal Medicine** is still the mainstay of health care in several developing countries. The widespread use of herbal remedies and health care preparations, as those described in ancient texts such as the Vedas and are obtained from commonly used traditional herbs and medicinal plants have been traced for the occurrence of natural products with medicinal properties. A number of interesting outcomes have been found with the use of a mixture of natural products to treat diseases, most notably the synergistic effects and poly pharmacological application of plant extracts (Gibbons, 2003).

In **India** thousands of species of plants are known to have medicinal value and the use of different parts of several medicinal plants to cure specific ailments has been in vogue since ancient times. Purohit and Vyas reckon that about 70,000 species of the plant kingdom have been used as herbal medicine at one or other time. Ayurveda is the science of life, prevention and longevity. It is the oldest (over 5000 years) and most holistic medical system available today. This system traces its origins to the Vedas, Atharvaveda in particular. Ayurveda or Ayurvedic medicine is a system of
traditional medicine, which is native to India (Chopra and Ananda, 2003) and form an alternative system of medicine. The earliest literature on Indian medical practice appeared during the Vedic period in India. In Ayurveda a number of indigenous plants having medicinal value are documented. The ‘Susruta Samhita’ and the ‘Charaka Samhita’ contain influential works on traditional medicine during this era and more than 700 plants are listed in these literature. Over the following centuries, Ayurvedic practitioners developed a number of medicinal preparations and surgical procedures for the treatment of various ailments (Dwivedi et al., 2007).

Today, world is gradually turning to herbal formulations which are known to be effective against a large repertoire of diseases and ailments. More importantly, they are not known to cause any notable derogatory effects (Kirtikar and Basu, 1984) and are readily available at affordable prices (Sharma et al., 2008). In the developing countries synthetic drugs are not only expensive and inadequate for the treatment of diseases but are also often with adulterations and side effects (Bibitha et al., 2002). Hence different remedies evolved in different regions of the world (Britto and Senthilkumar, 2001). The World Health Organization has reported that more than 80% of the world’s population in developing countries depends primarily on herbal
medicine for basic healthcare needs. Hence, there is a need to search for plants of medicinal value.

Secondary metabolites are a wide range of active compounds and are biosynthetically derived from primary metabolites. They are more limited in their distribution in the plant kingdom. They varies in quality and quantity for a given plant species growing in different locations. They are frequently accumulated in smaller quantities tend to be synthesized by specialized cell types at distinct developmental stages (Yeoman et al., 1982; Endress, 1994; Edwards and Gatehouse, 1999). Many of the plant secondary metabolites are constitutive, exist in healthy plants in their biologically active forms, but others occur as inactive precursors and are activated in response to tissue damage or pathogen attack (Osbourne, 1996). The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plant such as alkaloids, steroids, tannins, flavonoids, resins, fatty acids etc. Out of the total number of secondary metabolites reported in the dictionary of natural products, 33,000 are terpenoids, 16,000 alkaloids and 8,182 flavonoids (Chapman and Hall, 1998). These being an integral part of the basic metabolism also have an ecological role and are often involved in plant protection against biotic or
abiotic stresses (Weisshaar and Jenkines 1998; Hattenschwiler and Vitousek, 2000). Some secondary metabolites such as flavonoids are also involved in cell pigmentation in flower and seed, which attract pollinators, seed dispersers and are also involved in plant reproduction (Winkel-Shirley, 2001). Moreover, plant secondary metabolites have pharmaceutical properties effective for human health (Raskin et al., 2002; Reddy et al., 2003).

**Alkaloids** are group of naturally occurring chemical compounds. They are widely distributed and about 5500 alkaloids are known, comprising the largest single class of secondary plant metabolites. They are known to have pharmacological effects and are used in medication, as recreational drugs and in entheogenic rituals. A benzyliisoquinoline alkaloid, papaverine has shown to have inhibitory effect on several viruses and indoquinoline alkaloids from *Cryptolepsis sanguinolenta* displayed activity against a number of gram-negative bacteria and yeast (Silva *et al.*, 1996). Quinine, an alkaloid, is popular for its anti malarial activity against the malaria parasite (Iwu *et al.*, 1999). Literature indicates that plant alkaloids have considerable biological activity (Cowan, 1999; Okunade *et al.*, 2004). Many alkaloids are also toxic to other organisms.
Flavonoids are group of poly phenolic compounds. They are ubiquitous in photosynthesizing cells and are commonly found in fruits, vegetables, nuts, seeds, stems, flowers, tea, wine, propolis and honey. They are known to have medicinal properties and play a major role in the successful medical treatments from ancient times and their use has persevered till date (Dixon et al., 1998). They are potent water-soluble antioxidants and free radical scavengers, which prevent oxidative cell damage and have strong anti-cancer activity (Del-Rio et al., 1997; Okwe and Okue, 2004; Okue et al., 2006). They are used to improve aquaresis and as anti-inflammatory, anti spasmodic, and anti-allergic, anti microbial agents (Mills and Bone, 2000; Robbers and Tyler, 2000; Harborne and Williams, 2000). It was reported that flavonoids can improve the blood circulation and lower the blood pressure (Blumenthal, 2003).

In recent years, traditional system of medicine has become a topic of global discussion. Many of the plant species recognize as medicinal herbs have been scientifically evaluated for their possible medicinal applications. It has been mentioned that natural habitats for medicinal plants are disappearing fast and together with environmental and geopolitical instabilities; it is increasingly difficult to acquire plant derived compounds.
This has prompted industries, as well as scientists to consider the possibilities of investigation into cell cultures as an alternative supplement for the production of plant pharmaceuticals. Phyto compounds are known to play a major role in the adaptation of plants to their environment, but also represent an important source of pharmaceuticals (Ramchandra and Ravishankar, 2002).

The use of plants and their extract for the preparation of herbal drugs provides the foundation to modern therapeutic sciences and thus enabled the man to establish the empirical system of medicine. Hence, several plant species are being screened for these herbal compounds and are also isolated from the plants.

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia or increased blood glucose level with disturbance in carbohydrate metabolism resulting from absolute or relative lack of insulin secretion (report of a WHO consultation, Geneva, 1999). The frequency of this disorder is on the rise globally and is likely to hit 300 million by 2025. In India projected to have the largest number of diabetic cases (Gupta O.P. and Phatak S., 2003).
There are three forms of diabetes mellitus - Type I (Insulin dependent) and Type II (Insulin independent) and Gestational Diabetes mellitus.

**Type I** diabetes is called insulin-dependent, immune mediated or juvenile onset diabetes which is caused due to insulin insufficiency because of lack of functional beta cells (Cooke and Plotnick, 2008) or by an auto immune reaction where the body’s defense system attacks the insulin producing cells. This disease can affect people of any age, but usually occurs in children or young adults. Patients suffering from Type I are therefore totally dependent on exogenous source of insulin everyday to control the level of glucose in their body.

**Type II** diabetes mellitus is known as non-insulin dependent diabetes mellitus (NIDDM) or maturity onset diabetes. It is characterized by insulin resistance and relative insulin deficiency, either of which may be present at the time that diabetes becomes clinically manifest. The diagnosis of NIDDM usually occurs after the age of 40 but can occur earlier, especially in population with high diabetes prevalence. Patients suffering from Type II diabetes (insulin independent) are unable to respond to insulin and can be treated with dietary changes, exercise and medications (Elley and Kenealy,
2008). The most prevalent form both in the global and Indian scenario is the non insulin dependent diabetes mellitus which is associated with elevated postprandial hyperglycemia (PPHG) (WHO, 2006).

**Gestational** diabetes mellitus (GDM) is a form of diabetes consisting of high blood glucose level during pregnancy. It develops in one among 25 pregnancies worldwide. It usually disappears after pregnancy but women with GDM and their offspring are at an increased risk of developing NIDDM later in life.

**The prevalence** of Type II diabetes is on increase and literally it can be said that India is also facing a diabetic explosion. Of the total diabetics about 90% have NIDDM, which is characterized by PPHG and associated with postprandial oxidative stress. PPHG (increase in blood sugar level after a meal) plays an important role in the development of complications associated with the condition. One of the long term complications of NIDDM is hypertension or high blood pressure. Hypertension and NIDDM are interrelated metabolic disorders. Persistent hypertension is one of the risk factors for strokes, heart attacks, heart failure and is a leading cause of chronic renal failure. Experimental evidences suggest the involvement of free radicals in the
Introduction

Pathogenesis of diabetes and more importantly in the development of diabetic complications. Free radicals are capable of damaging cellular molecules, DNA, proteins and lipids leading to altered cellular functions. For the development of diabetic complications, the abnormalities produced in lipids and proteins are the major etiologic factors. In diabetic patients, extra-cellular and long lived proteins, such as elastin, laminin and collagen are the major targets of free radicals. These proteins are modified to form glycoproteins due to hyperglycemia. The modification of these proteins present in tissues such as lens, vascular wall and basement membranes are associated with the development of complications of diabetes such as cataracts, microangiopathy, atherosclerosis and nephropathy. As diabetes is a multifactorial disease leading to several complications, and therefore demands a multiple therapeutic approach.

Control of PPHG can be done by various mechanisms such as- (1) stimulation of beta cells in the pancreas to produce more insulin, (2) increasing the sensitivity of tissues to insulin, (3) decreasing gluconeogenesis by the liver and (4) delaying the absorption of carbohydrates from the gastrointestinal tract by glycosidase inhibitors.
Alpha amylase (E.C.3.2.1.1) belongs to the class of α-1,4-glucan-4-glucanohydrolases is one of the important target enzymes for the conventional treatment of diabetes. There are two types of alpha amylase in human beings-salivary alpha amylase and pancreatic alpha amylase. It catalyses the initial step in hydrolysis of starch to maltose and maltotriose which are then acted upon by α-glucosidases, broken down into glucose that gets absorbed by the brush border epithelium of the intestine and enters the blood stream. Degradation of this dietary starch proceeds rapidly and leads to elevated post prandial hyperglycemia (PPHG). It has been shown that activity of human pancreatic amylase in the small intestine correlates to an increase in post prandial glucose levels, the control of which is therefore an important aspect in treatment of diabetes (Eichler H.G. et al., 1984). Hence, retardation of starch digestion by inhibition of enzymes such as alpha amylase would play a key role in control of diabetes (Patwardhan B. et al., 2004).

Alpha amylase inhibitors play major role in the management of postprandial hyperglycemia (Bhat M. et al., 2008). It inhibits the action of alpha amylase enzyme leading to reduction in starch hydrolysis to maltose and consequentially lowers postprandial hyperglycemia. The strategy employed by most of the conventional anti-diabetic drugs available in the market such as
acarbose, voglibose and miglitol is by the inhibition of these α-amylase and α-glucosidase enzymes (Gholamhosenian et al., 2008). These α-glucosidase inhibitors have gastrointestinal side effects such as bloating, abdominal discomfort, diarrhea and flatulence (Cheng et al., 2005). Thus extensive search for naturally available amylase and glucosidase inhibitors is a promising field of present day research. Natural α-amylase and α-glucosidase inhibitors from traditionally valued medicinal and food plants can provide benefit by controlling PPHG without side effects posed by most of the conventional drugs available for diabetes (Farias et al., 2008). Therefore, the search for more safer, specific and effective hypoglycemic has continued to be an important area of investigation with natural extracts steadily available from traditional medicinal plants offering great potential for discovery of new anti diabetic drugs (Klein et al., 2007).

**Medicinal plants** have always been an exemplary source of drugs. Traditional medicinal plants with their various biological constituents have been used effectively by the communities since long time to treat diseases. It has been estimated that more than 800 species of plants exhibit hypoglycemic properties, including many common plants (Alarcon – Aguilara et al., 1998). Plant extracts or bio-active herbal compounds have been reported scientifically
for their biological activities.

**Administration of** sulfur containing amino acid (S-methyl Cysteine Sulphoxide) isolated from *Allium cepa* Linn. at a dose 200 mg/kg for 45 days showed anti diabetic and hypolipidaemic effects in alloxanized rats (Kumari K. *et al.*, 1995). Oral administration of 0.25 gm/kg allicin (isolated from *Allium sativum* Linn.) exhibited hypoglycemia in diabetic rabbits (Mathew P.T., 1973). Hydroalcoholic extract of *Azadirachta indica* A Juss showed hypoglycemic and anti-hyperglycemic effect in normal, glucose fed and streptozotocin induced diabetic rats (Chattopadhyay R.R., 1987). Mangiferin from stem bark of *Mangifera indica* Linn. showed anti cancer, anti microbial, anti oxidant and anti atherogenic effects (Qian H. *et al.*, 2007). *Aloe vera* L. leaves have been reported to possess different components such as mannans, polymannans, anthrones, anthraquinones and various lectins (Boudreau M.D., 2006; King G.K. *et al.*, 1995; Eshun K, 2004).

**The field of nanotechnology** is one of the most active areas of research in modern material sciences. Nanoparticles exhibit completely new or improved properties based on specific characteristics such as size, distribution and morphology. Nanotechnology is a field that is burgeoning day by day,
making an impact in all spheres of human life. New applications of nanoparticles and nanomaterials are emerging rapidly (W. Jshn, 1999; H.S. Naiwa, 2000; C.J. Murphy, 2008). Nano crystalline silver particles have found tremendous applications in the field of high sensitivity biomolecular detection and diagnostics, antimicrobials and therapeutics (M. Rai and A Yadav, 2009; J.L. Elechiguerra et al., 2005), Catalysis (R.M. Crooks, 2001) and microelectronics (D.I. Gittins et al., 2000). However, work is still required to be done for economical and commercially viable as well as environmentally clean synthesis route to synthesize silver nanoparticles.

A number of approaches are available for the synthesis of silver nanoparticles viz: reduction in solutions (D.V. Goia et al., 1998), chemical and photochemical reactions in reverse micelles (C. Taleb et al., 1997), thermal decomposition of silver compounds (K. Esumi et al., 1990), radiation assisted (A. Henglein 2001), electrochemical (Rodriguez- Sanchez et al., 2000), sonochemical (J.J. Zhu et al., 2000), microwave assisted process (Pastoriza Santos 2002) and recently via green chemistry route (N.A. Begum et al., 2009, H. Bar et al., 2009 and J.Y. Song 2009).

Biological methods of synthesis have paved way for the “greener
"synthesis" of nanoparticles and these have proven to be better methods due to slower kinetics, they offer better manipulation and control over crystal growth and their stabilization. This has motivated an upsurge in research on the synthesis routes that allow better control of shape and size for various nanotechnological applications. The use of some materials like plant extract (D. Jain et al., 2009), bacteria (N. Saifuddin et al., 2009), fungi (K.C. Bhainsa 2006) and enzymes (B. Willner et al., 2007) for the synthesis of silver nanoparticles offer numerous benefits of eco-friendliness and compatibility for pharmaceutical and other biomedical applications because toxic chemicals cannot be used in the synthesis protocol. Chemical synthesis methods lead to presence of some toxic chemical absorbed on the surface that may have adverse effect in the medical applications. Green synthesis provides advancement over chemical and physical method as it is cost effective, environment friendly, easily scaled up for large scale synthesis and in this method there is no need to use high pressure, energy, temperature and toxic chemicals.

**Silver** has long been recognized as having inhibitory effect on microbes present in medical and industrial process (R M Jose and Jose 2005, C Lok et al., 2007). The most important application of silver and silver nanoparticles is
in medical industry such as topical ointments to prevent infection against burn
and open wounds (MIP et al., 2006).

**Phytochemically mediated** synthesis of gold nanoparticles marks a
potential advance in the drug discovery era. A range of medicinal plants and
plant extracts has been used for biological synthesis of gold nanoparticles.

**Climatic conditions** may also affect the hypoglycemic effects of plants.
Hence for the present study plants were collected from two districts of
Rajasthan (Jaipur and Bharatpur). In the study, different extracts of selected
plants were subjected for silver nanoparticles synthesis by biological methods
and were screened and compared for their salivary alpha amylase inhibitory
activity in plants of two districts of Rajasthan.

**Plants selected for study**

**Aloe vera L.**

*Aloe vera* L. belonging to family Xanthorrhoeace is a **succulent**
plant species that is found only in cultivation, having no naturally occurring
populations, although closely related *aloes* do occur in northern Africa
(Akinyele and Odiyi, 2007).
*Aloe vera* is a stemless or very short-stemmed succulent plant growing to 60–100 cm (24–39 in) tall, spreading by offsets. The leaves are thick and fleshy, green to grey-green, with some varieties showing white flecks on their upper and lower stem surface (Yates, 2002). The margin of the leaf is serrated and has small white teeth. The flowers are produced in summer on a spike up to 90 cm (35 in) tall, each flower being pendulous, with a yellow tubular corolla 2–3 cm (0.8–1.2 in) long. Like other *Aloe* species, *Aloe vera* forms arbuscular mycorrhiza, a symbiosis that allows the plant better access to mineral nutrients in soil (Gong *et al*., 2002).

*Aloe vera* leaves contain phytochemicals such as acetylated mannans, polymannans, anthraquione C, glycosides, anthrones, anthraquinones such as emodin and various lectins (King *et al*., 1995: Eshun *et al*., 2004).

Two reviews of clinical studies revealed that oral administration of *Aloe vera* might be effective in reducing blood glucose in diabetic patients and in lowering blood lipid levels in hyperlipidaemia. More and better trial data are needed to define the clinical effectiveness of this popular herbal remedy more precisely (Feily and Namazi, 2009).

*Allium cepa* L.
The onion (*Allium cepa*) belonging to family Amaryllidaceae, also known as the bulb onion, is used as a vegetable and is the most widely cultivated species of the genus *Allium*.

*Allium cepa* is known exclusively from cultivation, but related wild species occur in Central Asia. The onion plant (*Allium cepa*) is unknown in the wild but has been grown and selectively bred in cultivation for at least 7,000 years. It is a biennial plant but is usually grown as an annual. Modern varieties typically grow to a height of 15 to 45 cm (6 to 18 in). The leaves are blueish-green and grow alternately in a flattened, fan-shaped swathe. They are fleshy, hollow and cylindrical, with one flattened side. They are at their broadest about a quarter of the way up beyond which they taper towards a blunt tip. The base of each leaf is a flattened, usually white sheath that grows out of a basal disc. From the underside of the disc, a bundle of fibrous roots extends for a short way into the soil. As the onion matures, food reserves begin to accumulate in the leaf bases and the bulb of the onion swell (Brickell and Christopher, 1992).

Most onion cultivars are about 89% water, 4% sugar, 1% protein, 2% fibre and 0.1% fat. They contain vitamin C, vitamin B₆, folic acid and
numerous other nutrients in small amounts. They are low in fats and in sodium, and with an energy value of 166kJ (40 kcal) per 100 g (3.5 oz) serving.

Onions contain chemical compounds such as phenolics and flavonoids that basic research shows to have potential anti-inflammatory, anti-cholesterol, anti-cancer and anti-oxidant properties. These include quercetin (Slimestad et al., 2007) and its glycosides, quercetin 3,4'-diglucoside and quercetin-4'-glucoside (Williamson et al., 1997; Olsson et al., 2010). There are considerable differences between different varieties in potential antioxidant content.

*Allium sativum* L.

*Allium sativum* belonging to family Amarrylidaeae, commonly known as garlic, is a species in the onion genus, *Allium*. *Allium sativum* is a bulbous plant. It grows up to 1.2 m (4 ft) in height. It produces hermaphrodite flowers.

Garlic is easy to grow and can be grown year-round in mild climates. While sexual propagation of garlic is indeed possible, nearly all of the garlic in cultivation is propagated asexually, by planting individual cloves in the ground (Small Farm News Archive, 2010).
Garlic is grown globally, but China is by far the largest producer of garlic, with approximately 10.5 million tonnes (23 billion pounds) grown annually, accounting for over 77% of world output.

Garlic has been used as both food and medicine in many cultures for thousands of years. Hippocrates, Galen, Pliny the Elder, and Dioscorides all mention the use of garlic for many conditions, including parasites, respiratory problems, poor digestion, and low energy. Its use in China dates back to 2000 BCE (Block E., 2010).

Animal studies, and some early research studies in humans, have suggested possible cardiovascular benefits of garlic. A Czech study found garlic supplementation reduced accumulation of cholesterol on the vascular walls of animals (Sovova and Sova, 2004). Another study had similar results, with garlic supplementation significantly reducing aortic plaque deposits of cholesterol-fed rabbits (Durak et al., 2002). Another study showed supplementation with garlic extract inhibited vascular calcification in human patients with high blood cholesterol (Durak et al., 2004). The known vasodilative effect of garlic is possibly caused by catabolism of garlic-derived polysulfides to hydrogen sulfide in red blood cells (RBCs), a reaction
that is dependent on reduced thiols in or on the RBC membrane. Hydrogen sulfide is an endogenous cardioprotective vascular cell-signaling molecule (Benavides et al., 2007).

Garlic has been found to enhance thiamin absorption, and therefore reduces the likelihood for developing the thiamin deficiency beriberi (Jones and Goebel, 2001).

**Azadiracta indica** A Juss.

*Azadirachta indica*, also known as Neem, Nimtree, and Indian Lilac is a tree in the mahogany family Meliaceae. It is one of two species in the genus *Azadirachta*, and is native to India, Pakistan, and Bangladesh growing in tropical and semi-tropical regions. Its fruits and seeds are the source of neem oil.

Neem is a fast-growing tree that can reach a height of 15–20 meters (49–66 ft), rarely to 35–40 meters (115–130 ft). It is evergreen, but in severe drought it may shed most or nearly all of its leaves. The branches are wide and spreading. The fairly dense crown is roundish and may reach a diameter of 15–20 meters (49–66 ft) in old, free-standing specimens. The neem tree is very similar in appearance to its relative, the Chinaberry (*Melia azedarach*).
The opposite, pinnate leaves are 20–40 centimeters (7.9–16 in) long, with 20 to 31 medium to dark green leaflets about 3–8 centimeters (1.2–3.1 in) long. The (white and fragrant) flowers are arranged in more-or-less drooping axillary panicles which are up to 25 centimetres (9.8 in) long. The fruit is a smooth (glabrous) olive-like drupe which varies in shape from elongate oval to nearly roundish, and when ripe are 1.4–2.8 centimetres (0.55–1.1 in) by 1.0–1.5 centimeters (0.39–0.59 in).

In India, the plant is variously known as "Sacred Tree," "Heal All," "Nature's Drugstore," "Village Pharmacy" and "Panacea for all diseases". Products made from neem trees have been used in India for over two millennia for their medicinal properties: neem products are believed to be anthelmintic, antifungal, antidiabetic, antiviral, contraceptive and sedative. It is considered a major component in Ayurvedic and Unani medicine and is particularly prescribed for skin diseases (S. Zillur and M. Shamim, 1993). Neem oil is also used for healthy hair, to improve liver function, detoxify the blood, and balance blood sugar levels (Neem, Tamilnadu.com, 2012). Neem leaves have been used medicinally since ancient times in India, Pakistan to give baths to children suffering from skin diseases. The leaves are used in this manner that first they are washed thoroughly. Then 5-10 leaves along with the branch are boiled till
the water turns green. The water is then used for various purposes. It is found to be useful in controlling high blood sugar level and it is said to clean up the blood.

However, insufficient research has been done to assess the purported benefits of neem. In adults, short-term use of neem is safe, while long-term use may harm the kidneys or liver; in small children, neem oil is toxic and can lead to death. Neem may also cause miscarriages, infertility, and low blood sugar.

*Mangifera indica* Linn.

The mango is a fleshy stone fruit belonging to the genus *Mangifera*, consisting of numerous tropical fruiting trees in the flowering plant family Anacardiaceae. The mango is native to South Asia, from where it has been distributed worldwide to become one of the most cultivated fruits in the tropics.

Mango trees (*Mangifera indica* L.) grow up to 35–40 m (115–130 ft) tall, with a crown radius of 10 m (33 ft). The leaves are evergreen, alternate, simple, 15–35 cm (5.9–14 in) long and 6–16 cm (2.4–6.3 in) broad. The flowers are produced in terminal panicles 10–40 cm (3.9–16 in) long; each flower is small and white with five petals 5–10 mm (0.20–0.39 in) long, with a
mild, sweet odor suggestive of lily of the valley. The fruit takes three to six months to ripen.

The energy value per 100 g (3.5 oz) is 250 kJ (60 kcal. Mango contains a variety of phytochemicals and nutrients (Ajila and Prasada, 2008).

Phytochemical and nutrient content appears to vary across mango species (Rocha et al., 2007). Up to 25 different carotenoids have been isolated from mango pulp, the densest of which was beta-carotene, which accounts for the yellow-orange pigmentation of most mango species. Peel and leaves also have significant polyphenol content, including xanthonoids, mangiferin and gallic acid (Chen and Tai, 2004).

The mango triterpene, lupeol (Barreto et al., 2008) is an effective inhibitor in laboratory models of prostate and skin cancers (Chaturvedi et al., 2008; Prasad et al., 2008; Nigam et al., 2007). An extract of mango branch bark called Vimang, isolated by Cuban scientists, contains numerous polyphenols with antioxidant properties in vitro (Saleem et al., 2004) and on blood parameters of elderly humans (Rodeiro et al., 2006).